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ELECTROSTATIC COATING METHOD AND APPARATUS

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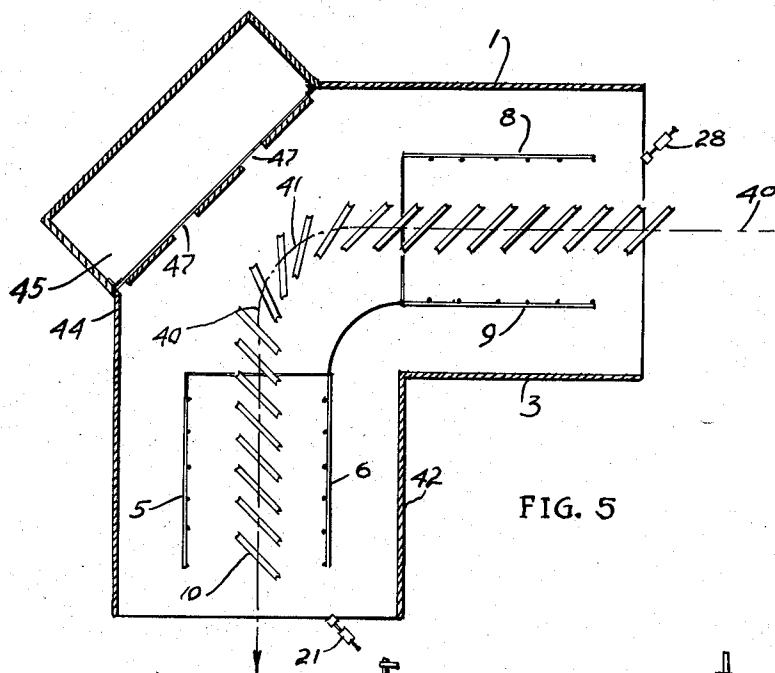


FIG. 5

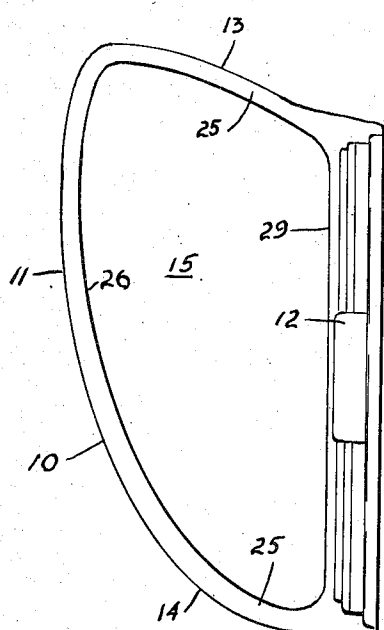


FIG. 3

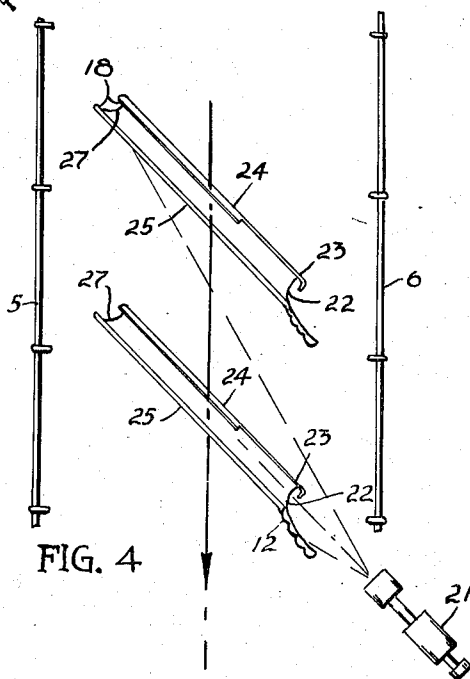


FIG. 4

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ELECTROSTATIC COATING METHOD AND APPARATUS

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This invention relates to the electrostatic coating of articles, and relates in particular to the application of a finish coating to an article in an electrostatic field.

Part of the disclosure set forth hereafter, which has not been claimed herein, is the subject of a patent application of mine, Serial No. 210,743 filed February 13, 1951. This latter application is a division of application, Serial No. 516,778 filed January 3, 1944, now abandoned which also is the basis of continuation-in-part application, Serial No. 596,870 filed May 31, 1945, now Patent No. 2,546,701.

Heretofore it has been proposed to atomize or nebulize paint or other liquids by directing an air stream against a stream of the liquid to break up or atomize the liquid stream. When employing such an atomizing apparatus in connection with coating in an electrostatic field, complete depositing of all the atomized liquid carried by the stream is rendered difficult, in part due to the turbulence or swirling which occurs at the extremities of the stream, which tends to carry the particles out of the influence of the electrostatic field, or interferes with the desired disposition of the particles in the field. A reduction in air pressure employed in atomizing the liquid necessitates a reduction in liquid being atomized, so that adequate coverage cannot be obtained in the same time interval, and in some instances adequate coverage cannot be obtained on all parts without excessive coating on other parts which results in a run or sag of the coat.

It is an object of the present invention to provide an electrostatic coating process which effects efficient utilization of the coating material.

Another object is the electrostatic coating of a series of articles which are maintained in a fixed position relative to the path of travel thereof.

A further object is the provision of an electrostatic coating process which results in depositing a coat of improved uniformity of masking quality.

A further object is the electrostatic coating of a series of articles in a manner to control the amount of coating material deposited on various surfaces of the article.

A further object is the spraying of coating material upon an article in a manner to control the amount of coating material electrostatically deposited on those surfaces of the article which are not in the direct path of the spray jet.

In accordance with one feature of the present invention, an object to be coated is moved

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through an electrostatic depositing zone and there is successively applied thereto a plurality of nonintermingled streams of finely divided coating material, preferably at such time intervals that there is formed a single blended layer of coating material thereon. By suitably arranging the direction of the streams or sprays of coating material at different electrostatic coating zones, one area of the article initially receives a light deposit or dust coat in the first treatment and a heavy deposit in the subsequent treatment, and areas which initially receive a heavy deposit in the first treatment receive a light deposit in the subsequent treatment with the result that all areas become covered by a coat of uniform hiding quality. In the absence of an electrostatic field, other operating conditions remaining the same, it would not be possible to obtain a preliminary light ancillary deposit on an area followed by a heavier deposit on the same areas from a common stream such as is obtained by the present invention.

According to another feature of the invention in the case of an article having areas to be coated which mutually bar each other to direct impingement of the particle stream, a plurality of articles are positioned in an ionizing electrostatic field to provide a relatively weak electrostatic field between adjacent articles while the articles are moving in a predetermined path through the electrostatic coating zone, and a stream of finely divided material is directed toward one barrier area, subtending area or intercepting surface which results in a relatively heavy deposit of material on the barrier area. In this case the spray is directed so that during part of the time some of the particles will pass in a relatively straight path through the region or space between the articles where a relatively weak field exists and will enter the strong ionizing and precipitating region on the opposite side and will be deposited on the protected areas on that side of the respective articles. This results in the deposit of a relatively heavy coat on the barrier area of the articles opposite the spray, and a relatively light coat on protected areas of the articles.

In those cases where a uniform coating over the article is desired a second stream of finely divided material is directed toward the lightly coated area, at another station along the path of travel of the article removed from the first station a suitable distance to prevent billowing of the respective streams, so that the lightly coated area now receives a relatively heavy de-

posit of material while some particles pass in a relatively straight path through the region or space between the articles where a relatively weak field exists and will enter the strong ionizing and precipitating region on the opposite side and will be deposited on that side. The result is that each barrier and protected area receives two or more deposits at such time interval that they are blended into a unitary heavy coat so that the article becomes coated overall by a coat of substantially uniform hiding quality.

In practice the invention may be carried out by providing two jets of finely divided liquid material at points spaced along the path of movement of an article, each of the jets possessing a component of velocity toward said path and a component of velocity parallel to said path, the latter velocity components of the two streams having opposite directions relative to each other and maintaining an electrostatic field from a plurality of ionizing sources over the surface of the article in the region where it passes through each jet. In coating an article having a length and breadth materially greater than the thickness thereof, or especially where the article is an open frame, a plurality of the articles preferably are maintained in spaced substantially parallel overlapped relation oblique to their path of movement so as to provide an electrostatic field of reduced strength therebetween, and streams of finely divided liquid material are directed from opposite sides of the path of movement to enter the spaces between the articles at spaced stations so that at each station some of the material passes through and is deposited on those surfaces of the article which are not in the direct path of the spray streams in addition to the deposits on those areas directly in the path of said streams.

The relation of the thickness of deposit in the areas of heavy deposit to that in the lightly coated areas, may be controlled under given particle stream conditions, by the positioning of the article in the electrostatic field, by the positioning of the spray gun or other device employed, by the spacing between the spray guns, by adjusting of fluid delivery of the spray guns and by other factors. Thus, for example, where the article to be coated presents a number of pairs of mutual barrier areas, it may be possible by selection of one pair of mutual barrier areas to receive the direct stream of particles, to provide sufficiently heavy deposits on all protected areas from the stream of particles that pass through the weak field so that only two spray stations are necessary to adequately coat the article. Where the two spray stations employ streams directed toward each other, they are positioned so as to avoid mutual interference and the consequent billowing, and by precipitating the coating particles from the respective streams, the electrostatic field obviates interference of the paint bearing streams. Fixed or movable spray guns may be employed at the spray stations, as desired, the use of a movable gun in effect being to increase the intercepting area of the article being coated.

The invention may be practiced with or without provision of an air exhaust for the carrier air, depending on the conditions of operation. Where an air exhaust is employed, the location of the exhaust port is preferably adjacent the extremity of one or more of the streams of coating material.

The invention will be described in greater detail in connection with the accompanying draw-

ings wherein are illustrated preferred embodiments of the invention by way of example and wherein:

Figure 1 is a partly diagrammatic sectional top view of a preferred embodiment of the invention,

Figure 2 is a side view of Figure 1, parts being in section,

Figure 3 is a side view of an article on an enlarged scale,

Figure 4 is a partly diagrammatic view on a distorted scale explaining the invention and showing a top view of articles to be coated, and

Figure 5 is a diagrammatic sectional top view of a modification.

Referring to the drawing in Figures 1 and 2 there is diagrammatically shown a spray booth 1 constructed of suitable material and having entrance and exit sections 2 and 3 through which passes a conveyor which is diagrammatically illustrated at 4. A pair of electrode frames 5 and 6, are spaced on opposite sides of the conveyor path at the entrance end 2. Each frame preferably carries a plurality of suitable ionizing electrodes, such as fine wires 7 giving a corona discharge when connected to a suitable source of high potential and which serve as sources of ionization. A similar pair of electrode frames 8 and 9 carrying suitable ionizing electrodes 7 are positioned at the exit end 3 on opposite sides of the conveyor. The frames 5, 6, 8 and 9 are connected preferably by lead wires 8' and 9' to the same source of high potential. If desired the frames 5, 8 and 6, 9 may be united into a pair of frames extending along the conveyor.

The objects to be coated, shown as automobile window frames or garnish mouldings 10 (Figs. 2 and 3) have vertical portions 11 and 12, and end portions 13 and 14 surrounding an aperture 15 which has a large area relative to the area of the surrounding frame portions. The mouldings are supported in a column from the conveyor by suitable spring hooks 17 (Fig. 2) engaging the turned flanges or beads 18 (Fig. 4), each frame being maintained inclined with respect to its path of travel through the apparatus and overlapping the adjacent frames to form a column of parallel members. The preferred axis of inclination to the path of travel is about 45°. The spacing of the frames along the conveyor preferably is such that only a weak electrostatic field between the frames is provided, and in the embodiment illustrated this space 19 is less than the width of a frame.

A spray gun 21 of any suitable type is located at the entrance end of the conveyor, and is positioned to direct a diverging stream of finely divided particles preferably air atomized and suspended in a carrier air stream at the window frames in the electrostatic field between the electrode frames 5 and 6. Any number of spray guns 21 may be employed, four being shown (Fig. 2), and the axis of the spray gun 21 (Fig. 4) may be substantially parallel to the inclination of the window frames. As the frame members are moved by the conveyor they pass successively through the spray from guns 21 so that the exterior subtending surface 22 of the end member 12 of each frame intercepts the spray to deposit particles directly on the intercepting surface. The frame also divides the stream so that part of the stream or spray passes between adjacent frame members. Of the part which passes between adjacent frame members, part is deflected and deposited by the electrostatic field upon the side portions 24 of the forward frame member

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and the interior face 26 of portion 11 thereof; part is deflected by and towards the adjacent rearward frame member and is deposited upon the side portions 25 and the interior portions 26 thereof; and some of the spray is impelled through the weak electrostatic field in the space between the frames and into the ionizing electrostatic field between electrode 5 and the column of frames, and under the confining and repelling influence of this portion of the electrostatic field is directed backwardly and deposited on the exterior faces 27 of portions 11. The frames thus receive heavy deposits in the directly exposed or subtending area 22, and relatively lighter deposits in protected areas. This action is made possible by the spacing of the frames along the conveyor which provides a field surrounding the stream passing between the frames that is strong enough to deflect part of the stream to cause deposition of particles upon the side portions 24 and 25 of adjacent frames, and which is weak enough to allow a substantial portion of the spray to pass completely through to the opposite ends 27 of the frames where it is confined and redirected by the plurality of ionizing elements 7, its direction being reversed by the field so as to cause deposition of the particles on ends 27. In this connection it will be noted that the provision of a plurality of ionizing sources 7 on at least one side of the column of articles is of particular value in confining the spray stream to prevent it passing out of the influence of the electrostatic field.

Adjacent the exit end of the booth is a second bank of spray guns 28 of a type like that previously described, the guns of the second bank being positioned at exit leg 3 of the conveyor to direct a stream of finely divided particles suspended in a carrier air stream at the window frames in the electrostatic field between electrode frames 8 and 9. The frames approach the spray guns 28 with the outside surface 27 of portion 11 facing the spray guns 28, which may be disposed with their axes substantially parallel to the inclination of the window frames. The outside subtending surfaces 27 of end members 11 now receive a coating from the direct stream of particles from the guns under influence of the electrostatic field, and part of the overspray which passes the outside of ends 11 is deflected by the electrostatic field and deposits on the inside 29 of end 12 and the side faces of members 11, 12, 13 and 14. The arrangement thus provides that certain areas previously receiving a coat from the electrostatically deposited overspray are directly exposed to the particle stream and receive a direct coating in the subsequent operation before the first coat has set or dried, so that the two deposits are blended into a unitary layer. It will be understood that the spray guns 21 and 28 may be disposed with their axes inclined to the plane of the mouldings as much as about 15°, that is, in the embodiment shown at an inclination of 30 to 45° to the line of travel of the mouldings.

At the middle of the booth are located exhaust chambers 31 (Fig. 1) connected at the top by a duct 32 with a suitable fan or exhaust system. Exhaust ports 33 are located between plates 34 to withdraw the carrier air from the extremities of the spray so that the exhaust air current travels longitudinally of the columns of articles in the direction from the spray guns toward the exhaust. The advantage of this construction is that interference of the two carrier or spray air streams is reduced or eliminated, with consequent reduction or elimination of billowing or turbulence in the

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depositing zone. Furthermore, the exhaust air current acts as a deflecting force to keep the particles in the electrostatic field between the electrodes and the column of articles where it is subject to the electrostatic depositing force. The elimination of billowing in the region of deposit remote from the spray gun is conducive to depositing uniform or smooth layers or coatings, and in general, contributes to the efficient performance of the coating operation.

In the modification illustrated in Figure 5, the conveyor 40 has a bend or elbow 41 of about 90° and in their course through the apparatus from the entrance to the exit end the frames are turned through 90° by reason of the change of direction of the conveyor, while maintaining their position relative to their path of travel. The spray booth 42 is similarly formed about the conveyor and at the exterior corner 44 of the booth is located the exhaust chamber 45 connected by a duct to a suitable fan or exhaust system. Exhaust ports 47 are located to withdraw the carrier air from the extremities of the spray so that the exhaust air current travels longitudinally of the columns of articles in the direction from the spray guns toward the exhaust. Thus interference of the two carrier or spray air streams is reduced or eliminated, with consequent reduction or elimination of billowing or turbulence in the depositing zone. For coating some articles, it may be desirable to dispose the spray guns to introduce the spray substantially tangentially to and in the direction of movement of the articles at one position, and at another position substantially tangentially to and opposed to the direction of motion.

If desired, there may be provided a series of ionizing electrodes across the bottoms of the pairs of frames 5, 6 or 8, 9 to thus provide a substantially trough shaped or U-shaped ionizing electrode. Various other modifications may be made in the invention without departing from the spirit or scope thereof.

I claim:

1. Apparatus comprising booth means having entrance and exit portions, said portions being disposed at an angle to each other, means for conveying an article to be coated through said portions, means for providing an electrostatic field over the surface of an article as it is moved through said entrance and exit portions, means for directing separate streams of finely divided coating material into said fields in said entrance and exit portions and generally toward the apex of said booth means for electrostatically depositing said material on the surfaces of said article whereby the material blends into a single layer, and gas moving means located in the vicinity of said apex and intermediate said entrance and exit portions for preventing interference between said streams and for facilitating the electrostatic deposition of coating material on said article.

2. Apparatus for coating articles, comprising a conveyor for conveying the articles in spaced relation successively through adjacent first and second coating zones, a booth enclosing said zones and into, through, and out of which the conveyor moves the articles over a predetermined path, said booth having an air-outlet opening located near the adjacent ends of said two coating zones, means for providing high-voltage electrostatic fields over and contiguous to the surfaces of articles in said two coating zones, means for withdrawing air through said outlet opening to induce in the first coating zone a movement of air

in the direction of article movement and in the second coating zone a movement of air counter to the direction of article movement, and means for directing separate streams of finely divided coating material into said fields from the upstream ends thereof generally toward said air outlet opening for electrostatic deposition on articles in the coating zones.

3. Apparatus for electrostatically coating a series of similar articles in each of which one of the three mutually perpendicular, over-all dimensions is materially less than either of the other two, said apparatus comprising a conveyor for moving the articles over a predetermined path, said conveyor including article supports for supporting the articles with the planes defined by the two greatest dimensions of each at substantially equal acute angles to the direction of motion of said conveying means, a booth enclosing adjacent first and second coating zones through which the articles are successively moved by the conveying means, said booth having an air outlet opening located near the adjacent ends of the coating zones, means for withdrawing air through said outlet opening to induce in the first coating zone a movement of air in the direction of article motion and in the second coating zone a movement of air counter to the direction of article motion, a first spray-discharge device located adjacent the upstream end of the first coating zone at one side of the article path and discharging a spray of liquid coating material into the first coating zone generally parallel to the planes of the articles therein and in the general direction of air movement through such first coating zone, a second spray-discharge device located adjacent the upstream end of the second coating zone on the opposite side of the article path and discharging a spray of liquid coating material into the second coating zone generally parallel to the planes of the articles therein and in the general direction of air movement through such second coating zone, and means for providing over and contiguous to the surfaces of the articles in each coating zone a high-voltage electrostatic field promoting the deposition of the coating material onto the articles.

4. Apparatus for coating articles, comprising a conveyor for conveying the articles in spaced relation successively through adjacent first and second coating zones, a booth enclosing said zones and into, through, and out of which the conveyor moves the articles over a predetermined path, said booth having an air-outlet opening located near the adjacent ends of said two coating zones, first and second coating-material discharge devices located to discharge streams of finely divided liquid coating material into the respective coating zones near the upstream ends thereof, said two devices being located on opposite sides of the article path and so oriented that each stream of finely divided coating material will be directed across the article path at such an angle thereto that some of the coating material particles will cross the article path through the spaces between adjacent articles, means for maintaining a high-voltage electrostatic field over and contiguous to the surfaces of the articles in each coating zone, said field-maintaining means including a discharge electrode located at each coating zone in spaced relation to the article-path and on the opposite side

thereof from the associated coating-material discharge device, said electrode being arranged transversely of the stream of coating material discharged from such device and extending both longitudinally and laterally of the article-path whereby coating-material particles which cross the article-path without becoming deposited on articles will be charged by said electrode, electrostatically redirected toward the article-path, and electrostatically deposited on the articles.

5. A method of electrostatically coating a plurality of articles, which comprises moving the articles in succession and in spaced relation over a predetermined path successively through first and second coating zones, creating in the first coating zone a movement of air in the direction of article movement and in the second coating zone a movement of air counter to the direction of article movement, discharging separate streams of finely divided liquid coating material into said coating zones from the upstream ends thereof, each of said streams being directed generally in the direction of air movement in the coating zone into which it is discharged, and maintaining over and contiguous to the surfaces of the articles in each coating zone a high-voltage electrostatic field to cause electrostatic deposition of the coating material onto the articles, said two coating zones being adjacent whereby the coating material deposited on the articles in the two coating zones blends into a single layer.

6. A method of coating a plurality of similar articles in each of which one of the three mutually perpendicular, over-all dimensions is materially less than either of the other two, comprising moving the articles through a first coating zone over a predetermined path while maintaining the articles in substantially parallel relation and at an acute angle to such path, then immediately moving the articles through a second coating zone while maintaining them in substantially parallel relation and at an acute angle to their path of movement, creating in the first coating zone a movement of air in the direction of article motion and in the second coating zone a movement of air counter to the direction of article motion, discharging into each coating zone adjacent the upstream end thereof a spray of liquid coating material directed toward the article path, generally parallel to the planes of the articles, and in the general direction of air movement in the coating zone, and maintaining over and contiguous to the surfaces of the articles in each coating zone a high-voltage electrostatic field promoting the deposition of the coating material onto the articles.

7. The invention set forth in claim 2 with the addition that said conveyor moves over a curved path between said first and second coating zone and tangentially of such curved path within said coating zones.

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The following references are of record in the file of this patent:

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